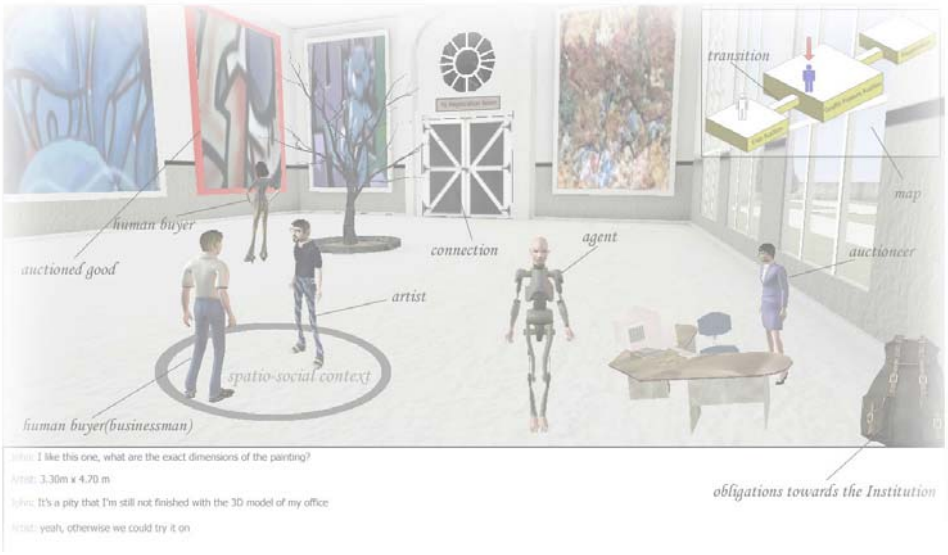
UNIVERSITY OF TECHNOLOGY SYDNEY

Virtual Institutions



A dissertation submitted for the degree of
Doctor of Philosophy in Computing Sciences

by

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as a part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Signature of Candidate

With gratitude

to my mother, who introduced me to life;

to my grandmother, who introduced me to writing;

to my father, who introduced me to research

and to my beautiful wife, who introduced me to love.

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Abstract

This thesis establishes Virtual Institutions as a comprehensive software engineering technology for the development of 3D Virtual Worlds that require normative regulation of participants' interactions (such as the commercially-oriented Virtual Worlds).

3D Virtual Worlds technology currently offers somewhat unregulated environments without means to enforce norms of behavior and interaction rules on their inhabitants. Furthermore, existing methodologies for Virtual Worlds development focus primarily on the design side of the "look-and-feel" of the inhabited space. Consequently, in current 3D Virtual Worlds it is difficult to keep track of the deviant behavior of participants and to guarantee a high level of security and predictable overall behavior of the system.

The Virtual Institutions Methodology proposed by this dissertation is focused on designing highly secure heterogeneous Virtual Worlds (with humans and autonomous agents participating in them), where the participants behave autonomously and make their decisions freely within the limits imposed by the set of norms of the institution. It is supported by a multilayer model and representational formalisms, and the corresponding tools that facilitate rapid development of norm-governed Virtual Worlds and offer full control over stability and security issues.

An important part of the Virtual Institutions Methodology is concerned with the relationship between humans and autonomous agents. In particular, the ways to achieve human-like behavior by learning such behavior from the humans themselves are investigated. It is explained how formal description of the interaction rules together with full observation of the users' actions help to improve the human-like believability of autonomous agents in Virtual Institutions. The thesis proposes the concept of implicit training, which enables the process of teaching autonomous agents human characteristics without any explicit training efforts required from the humans, and develops the computational support for this new learning method.

The benefits of using Virtual Institutions are illustrated through applying this technology to the domain of E-Commerce. It is demonstrated that providing shoppers with a normative environment that offers immersive experience and supports important real world attributes like social interaction, location awareness, advanced visualization, collaborative shopping and impulsive purchases can improve existing practices in E-Commerce portals.